



DARK ENERGY
SURVEY

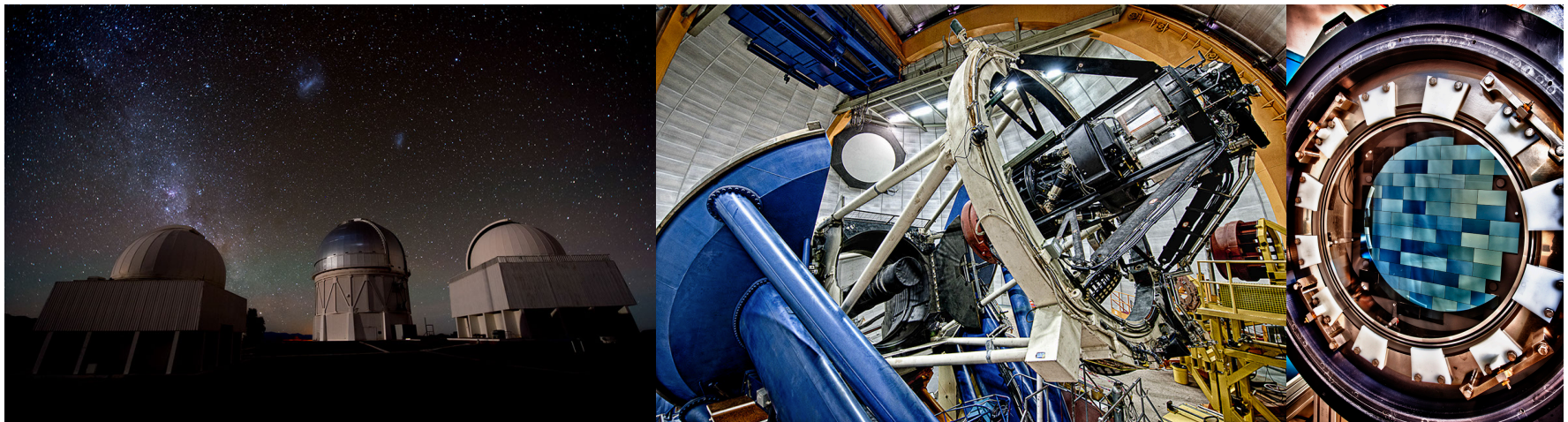


The Dark Energy Survey

Tesla Jeltema

University of California, Santa Cruz

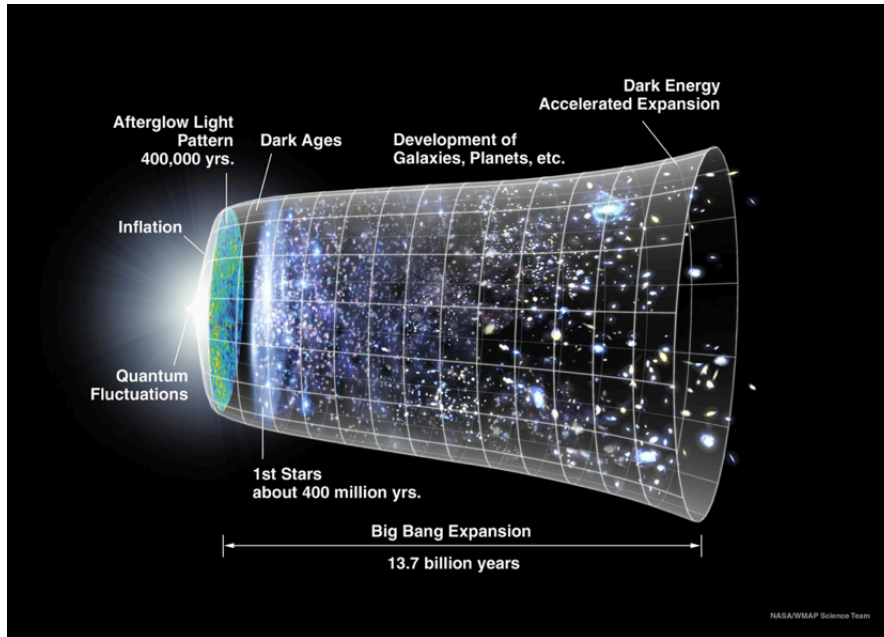
on behalf of the Dark Energy Survey Collaboration





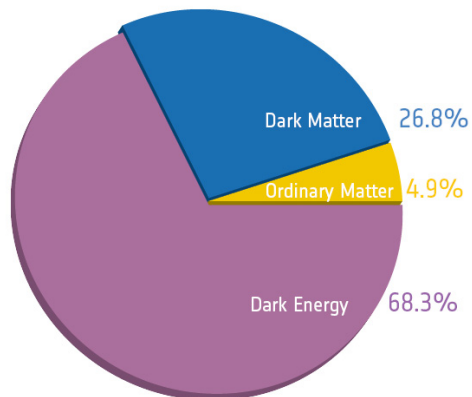
Dark Energy

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What is the cause of the observed cosmic acceleration?

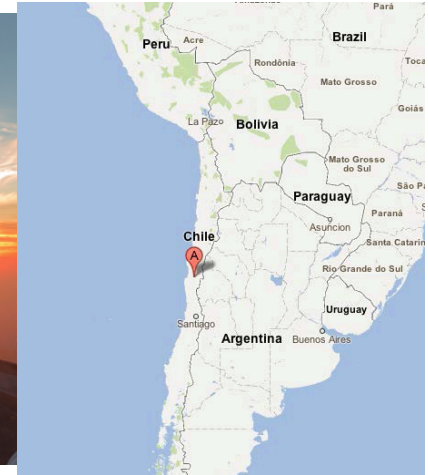
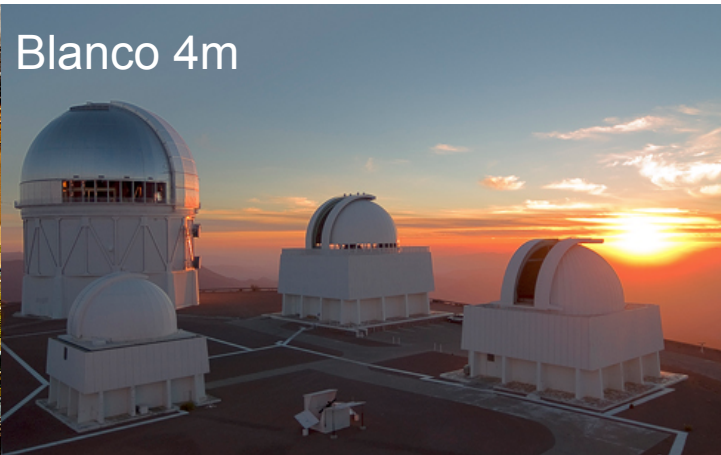
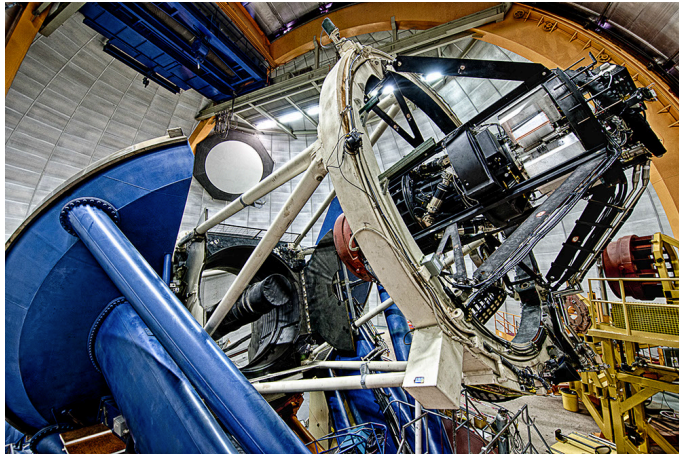
- Is it dark energy or a modification of general relativity?
- If it is dark energy, is it constant (Λ) or evolving; what is the DE equation of state?





The Dark Energy Survey

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DECam on the Blanco 4m at CTIO

- Optical imaging survey with 4-m Blanco telescope at CTIO in Chile
- 5000 deg² (1/8 of the full sky) in grizY bands
- 30 deg² SNe fields revisited
- DECam: 570 Megapixel Camera with 3 deg² FOV
- Runs 2013-2018, 525 nights



DES Collaboration

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Started in 2003, DES is now an international collaboration of ~200 scientists from 27 institutions

Fermilab, UIUC/NCSA, University of Chicago, LBNL, NOAO, University of Michigan, University of Pennsylvania, Argonne National Laboratory, Ohio State University, Santa-Cruz/SLAC/Stanford Consortium, Texas A&M



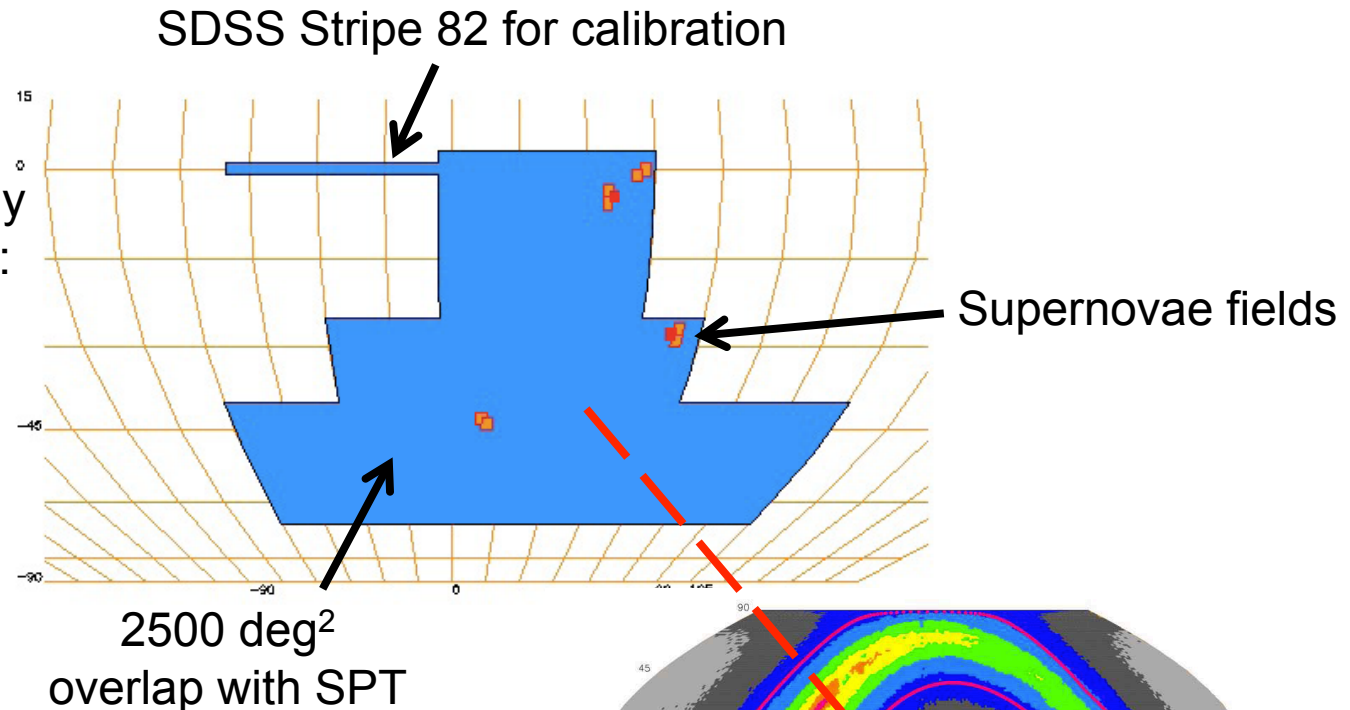


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DES Survey Footprint

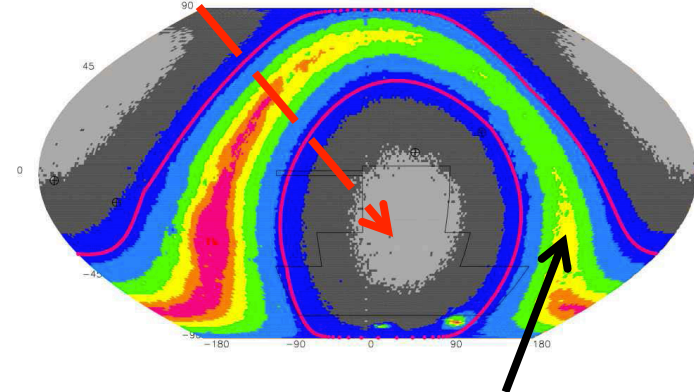
Overlap with as many
surveys as possible:

Stripe82, GAMA,
VVDS, eRosita,
BOSS, DEEP2,
PRIMUS, ...



Visible from Cerro Tololo September –
February

DECam available for community use
when DES not observing



Milky Way, equatorial projection



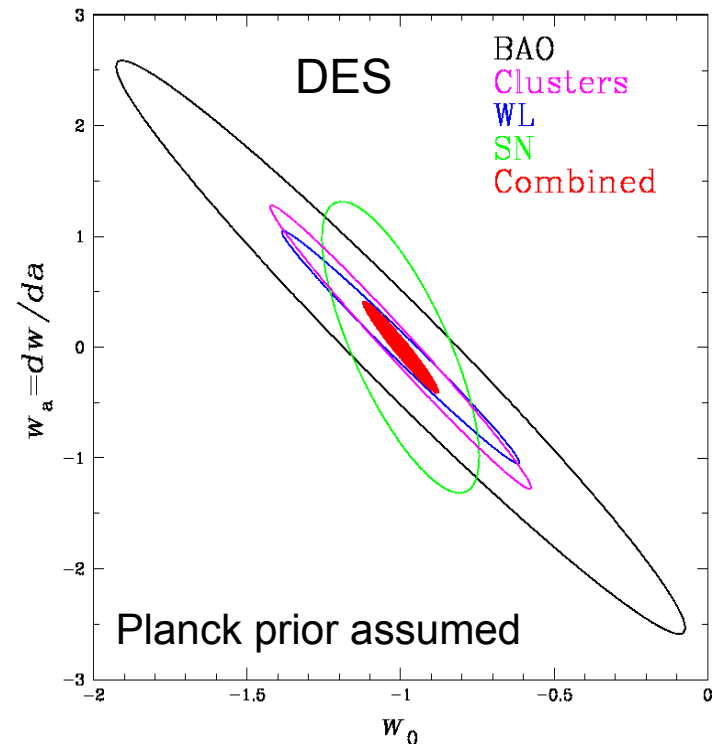
DES Science Overview

DARK ENERGY
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Four Probes of Dark Energy

- **Galaxy Clusters**
 - ~100,000 clusters to $z > 1$
 - Synergy with SPT, VHS
 - *growth of structure and geometry*
- **Weak Lensing**
 - Shape measurements of 200 million galaxies
 - *growth of structure and geometry*
- **Baryon Acoustic Oscillations**
 - 300 million galaxies to $z = 1$ and beyond
 - *Sensitive to geometry*
- **Supernovae**
 - 30 sq deg time-domain survey
 - ~4000 well-sampled SNe Ia to $z \sim 1$
 - *Sensitive to geometry*

Forecast Constraints on DE Equation of State



Factor 3-5 improvement over
Stage II DETF Figure of Merit



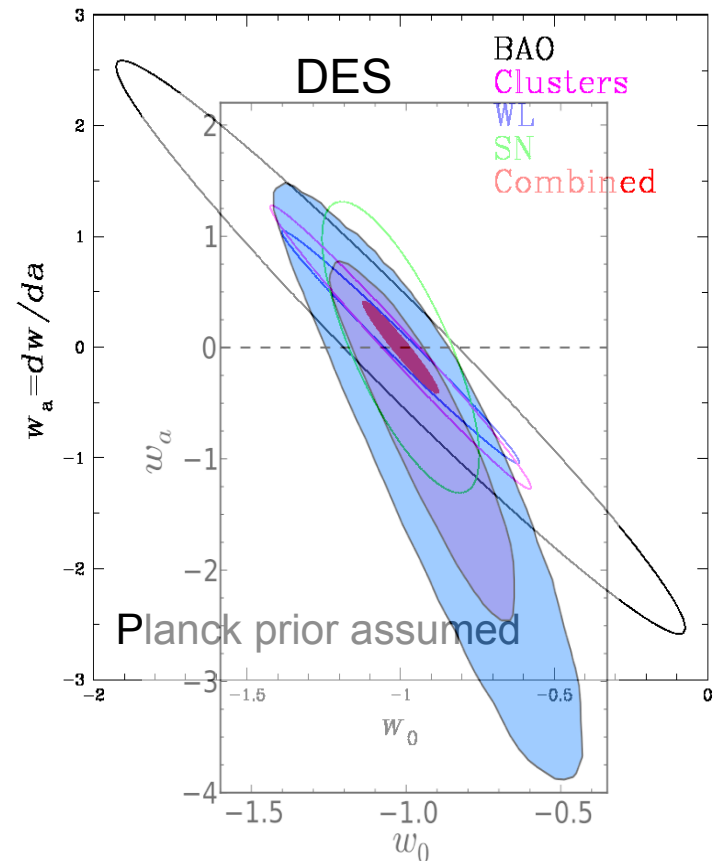
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Cluster Abundance

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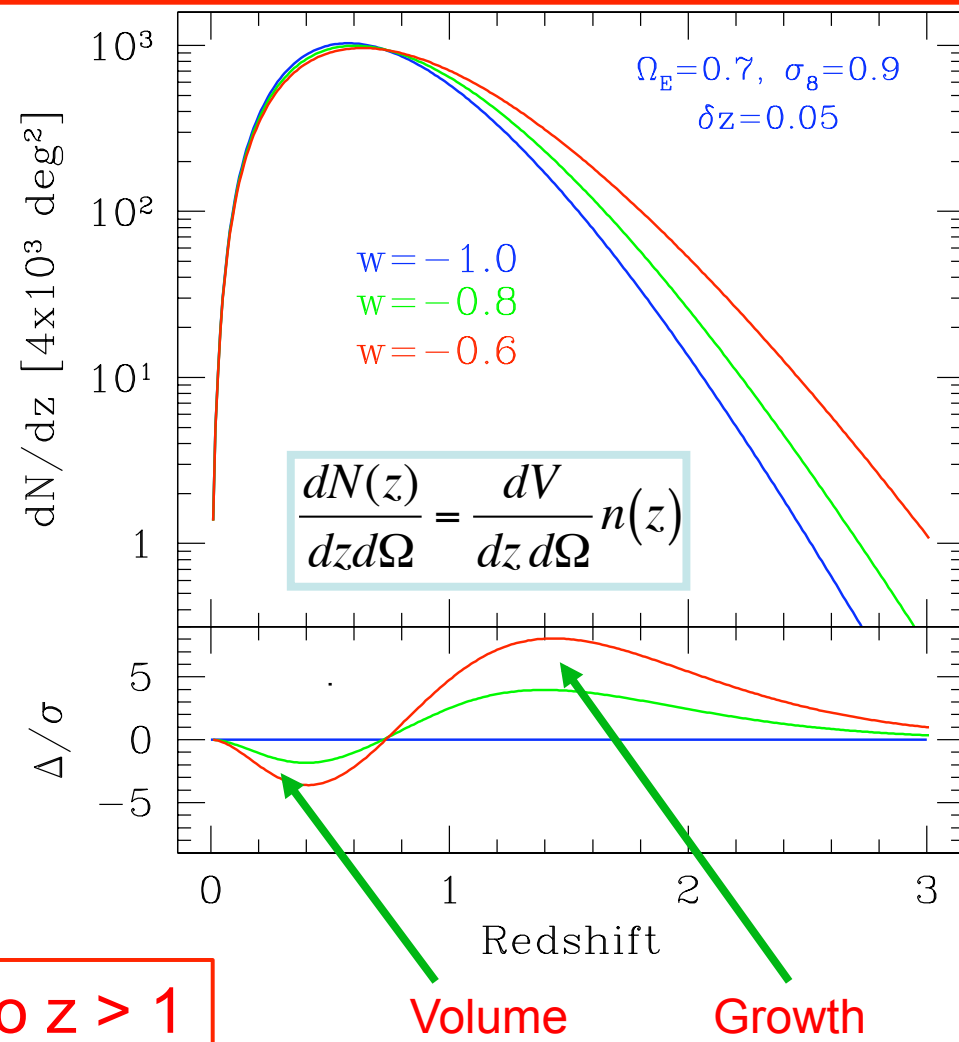
Number of clusters above
a mass threshold per
redshift per solid angle

Depends on:

- volume surveyed
- density of cluster

** Models are normalized to
produce same cluster
abundance at low redshifts

DES ~100,000 clusters to $z > 1$

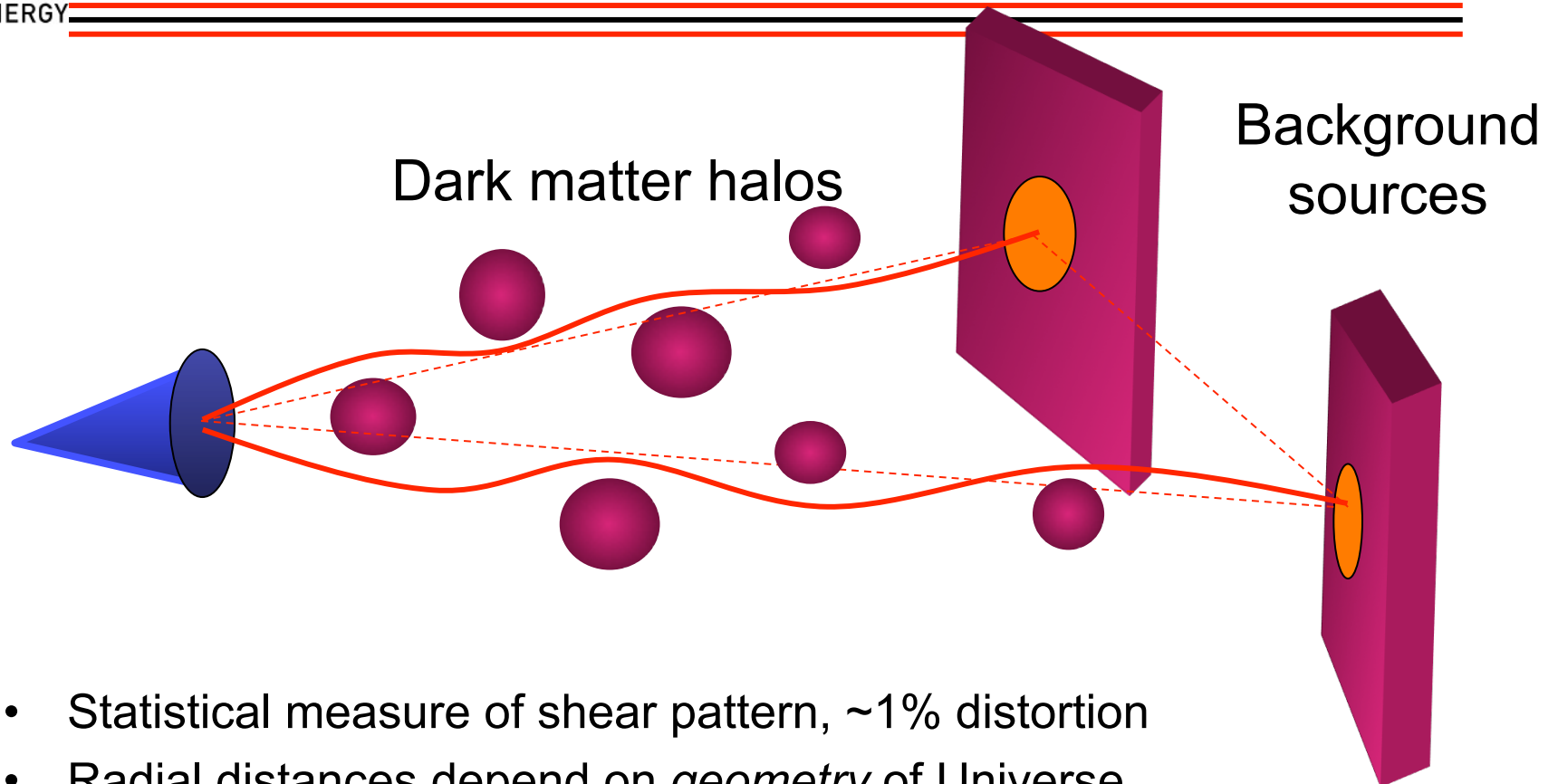


Mohr 2005



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Weak Lensing Cosmic Shear



- Statistical measure of shear pattern, $\sim 1\%$ distortion
- Radial distances depend on *geometry* of Universe
- Foreground mass distribution depends on *growth* of structure

DES shape measurements of 200 million galaxies



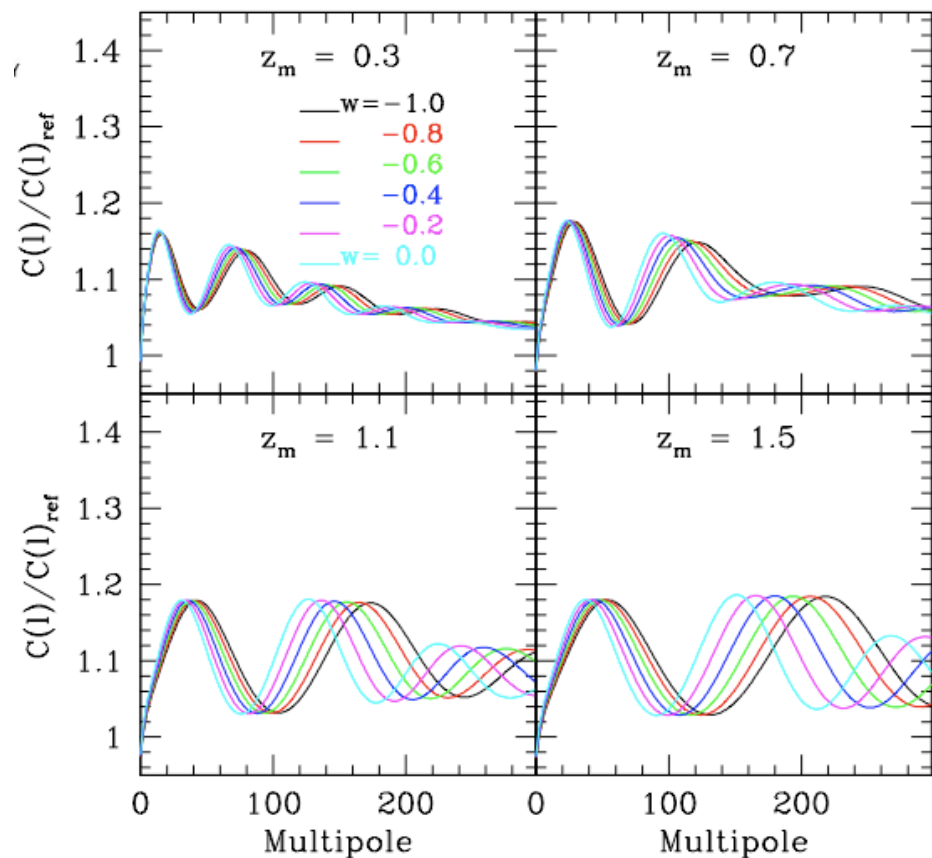
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Baryon Acoustic Oscillations

- Acoustic scale provides standard ruler. Scale set by last-scattering surface.
- Probe deeper than SDSS redshift survey (x10 increase in volume)

**DES 300 million galaxies
to $z > 1$**

Galaxy angular power spectrum in photo-z bins
(relative to model without BAO)



Fosalba & Gaztanaga



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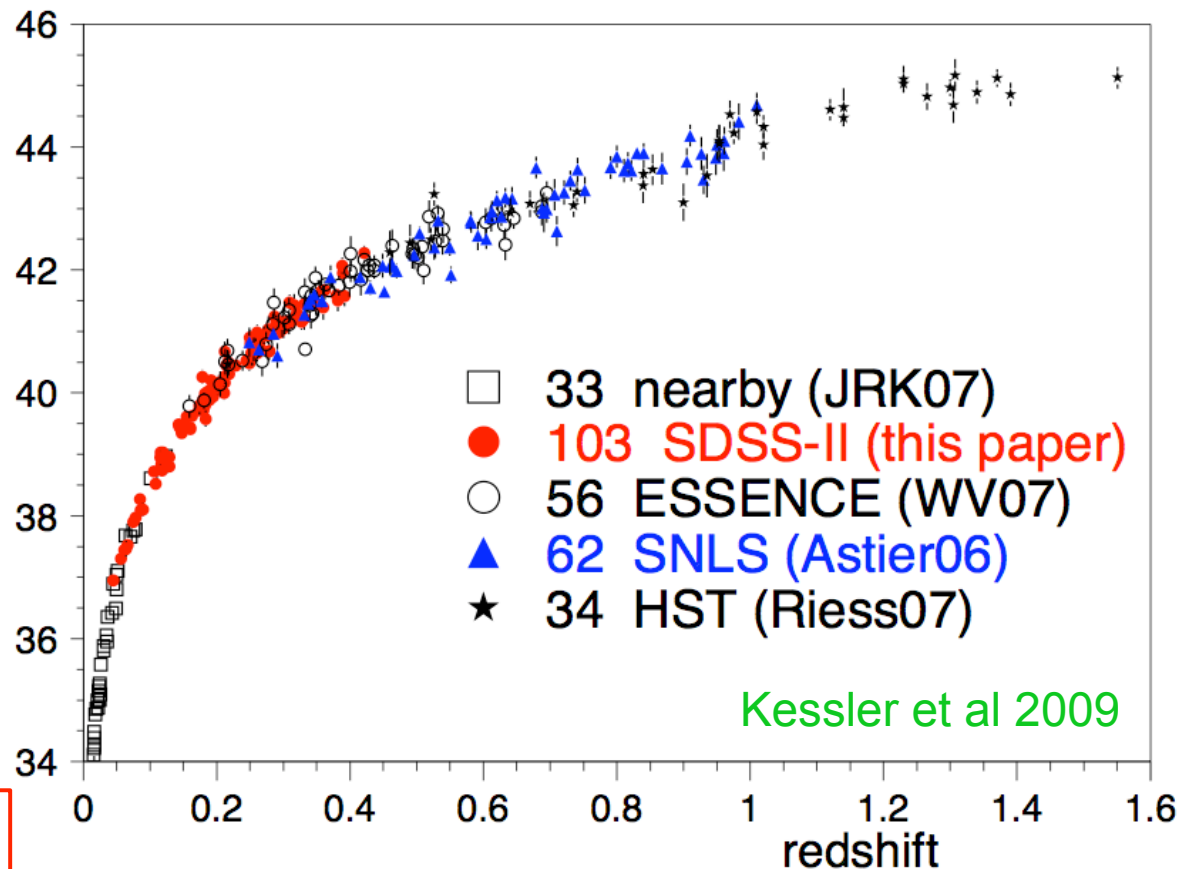
Supernovae

- Standard candles
- Probe geometry

- 30 deg² with ~5 day cadence
- Redshifts from spectroscopic follow-up, SN photo-zs and galaxy photo-zs
- Factor 2-4x statistics vs. other samples

DES ~4000 well-sampled SNe Ia to $z \sim 1$

Existing samples circa 2009

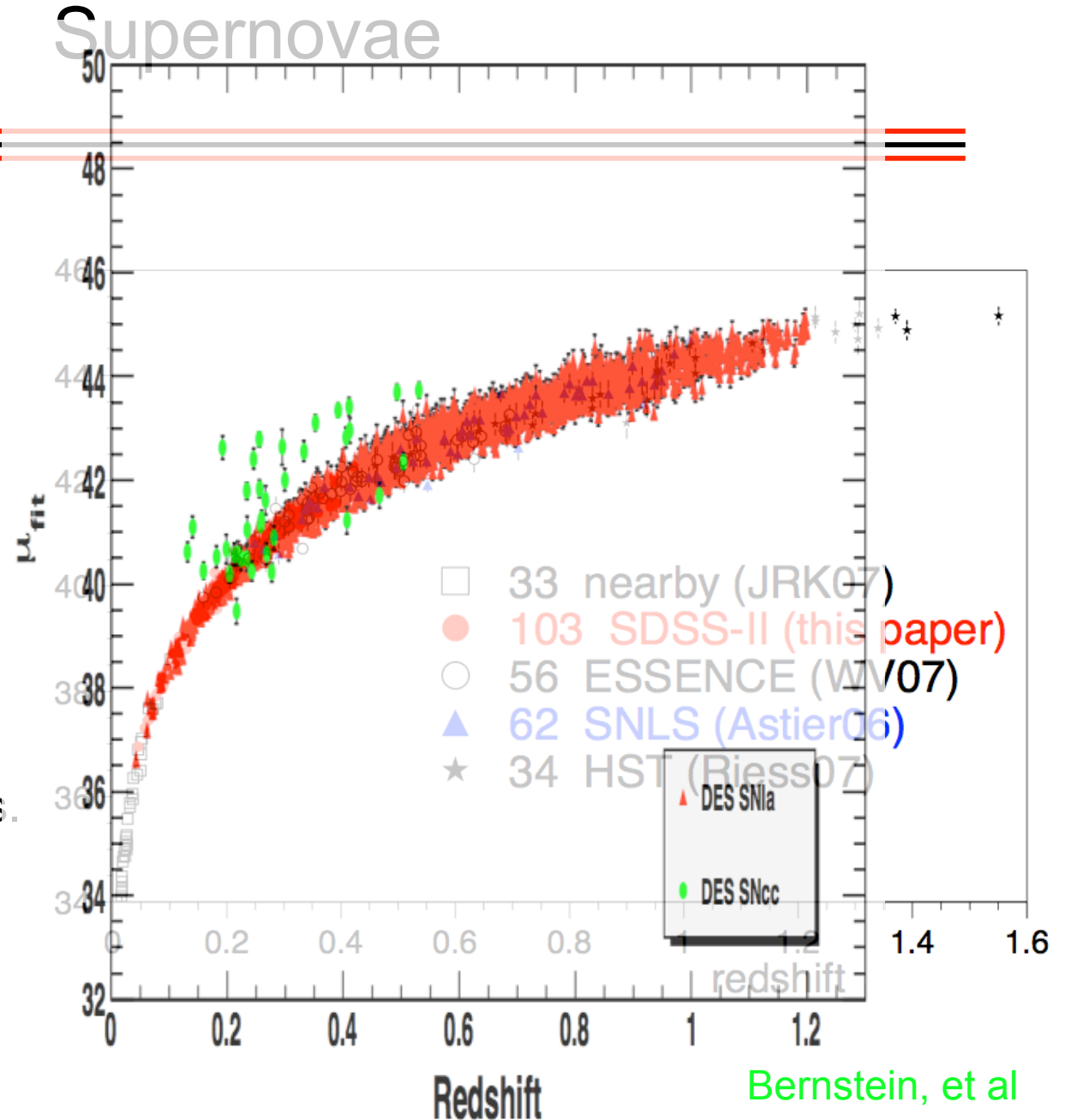




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- Standard candles
- Probe geometry

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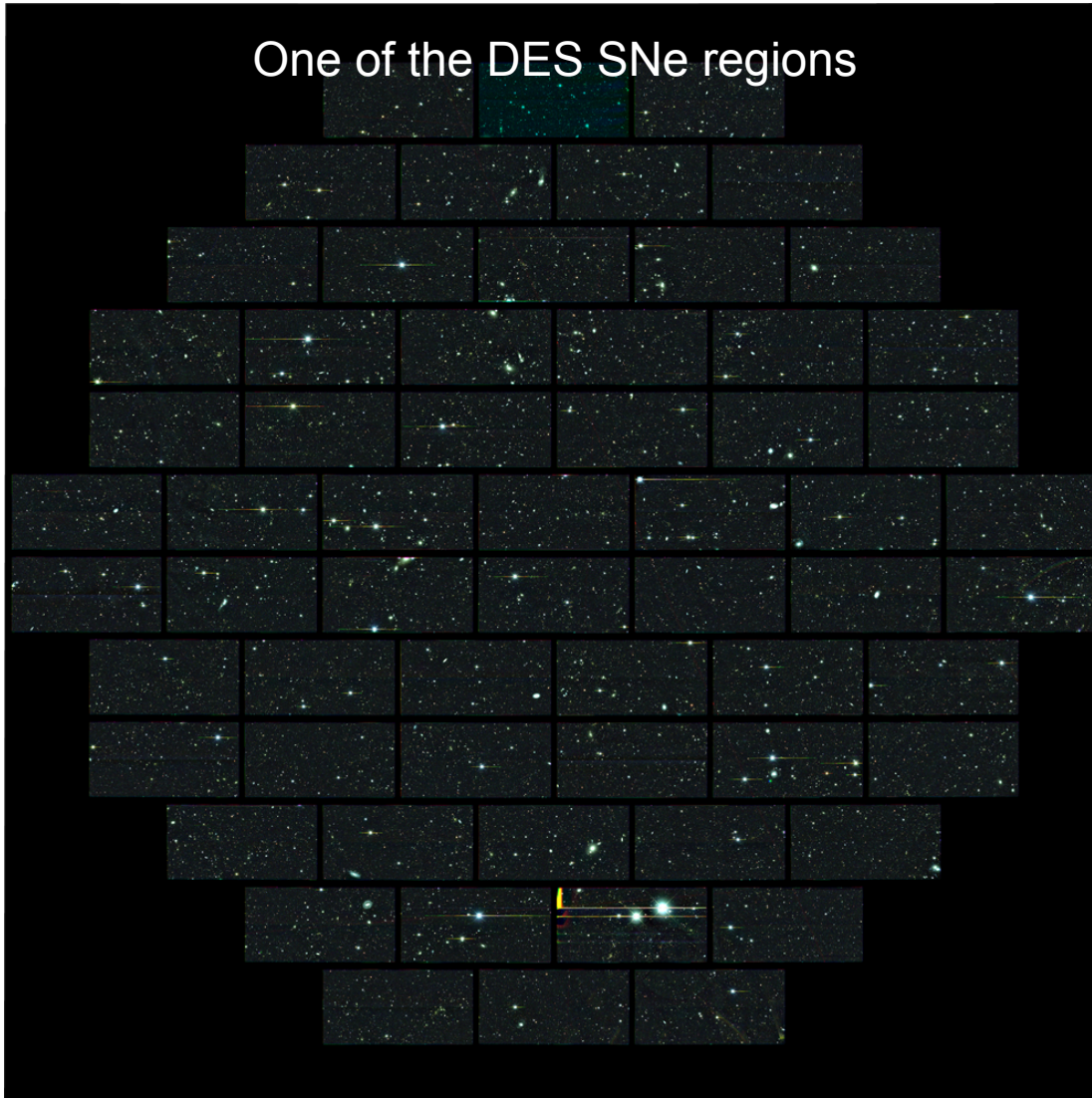




DES Survey Underway!

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One of the DES SNe regions



Survey Start
August 31, 2013

DECam image of
NGC1398 in Fornax cluster





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DES Timeline

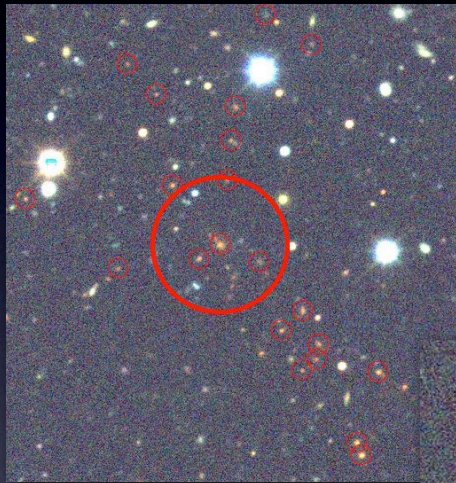
- Imager installation: Aug. 30, 2012
- First light: Sept. 12, 2012
- Commissioning: late Aug. to Oct. 2012
- Science Verification: Nov 2012 – Feb 2013
~115 deg² of data to full depth are now public
- First season: started August 31, 2013
- Raw DES survey data public after 12 months
- 2 public releases of DES coadd images & catalogs



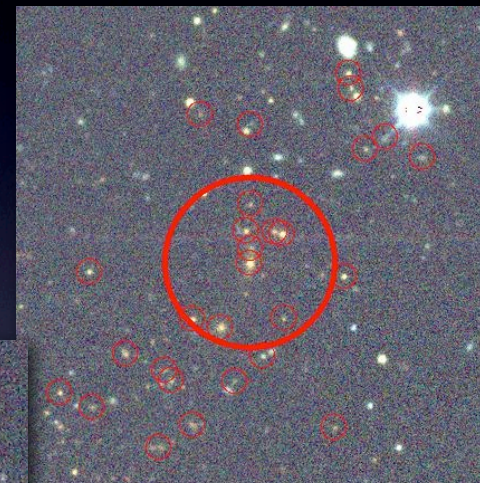
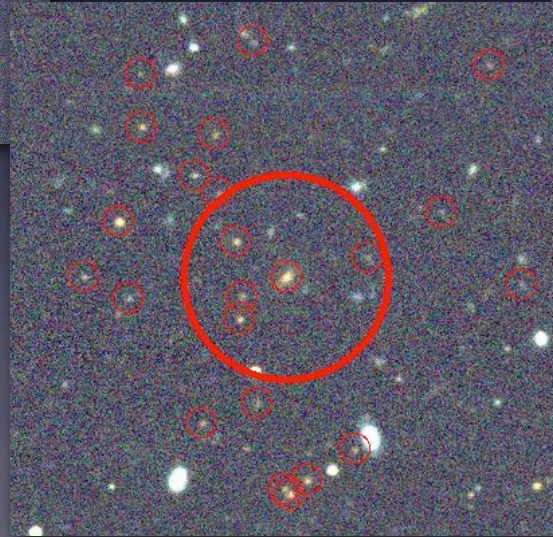
Early Results: High-Redshift Clusters

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New discoveries in science verification data



Found by E.
Rykoff, using
RedMapper



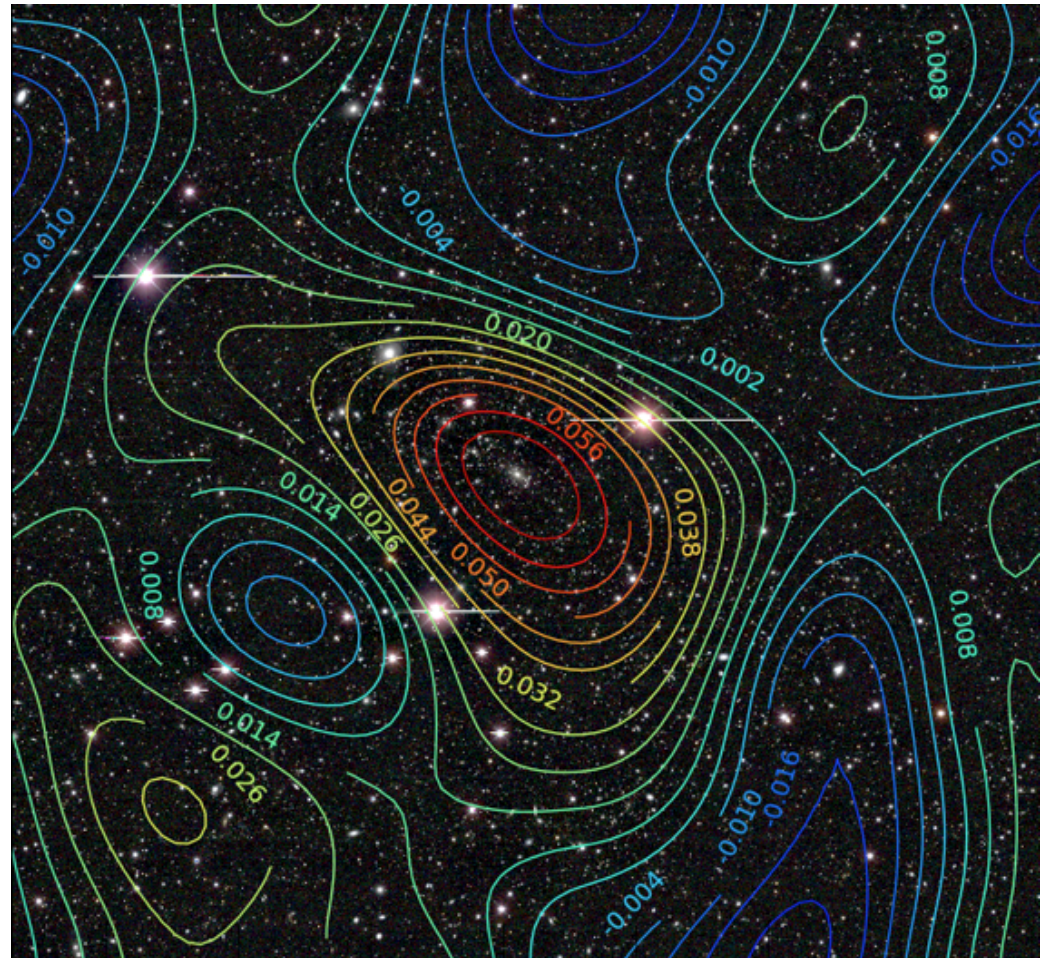
**$z > 0.8$
clusters!**



Early Results: Cluster Weak Lensing

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- Stacked (statistical) weak lensing cluster shear profiles will calibrate cluster mass-observable relations
- Preliminary cluster mass map from DES Science Verification data





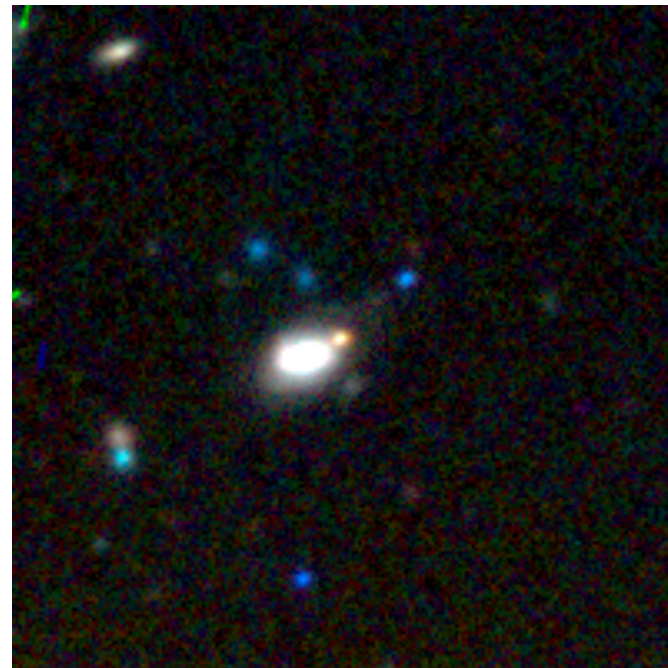
Early Results: Supernovae

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- 5 Type Ia and 2 Type II already spectroscopically confirmed.
- 500 good candidates scheduled for spectroscopic follow-up next season.



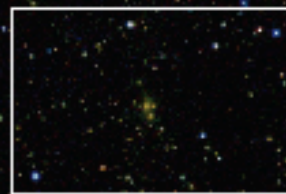
Nov. 7



Dec. 15

First confirmed SNe: SN Ia at $z=0.2$ confirmed at AAO





5 x 3

30 x 20 arcmin

